OBITUARY NOTICES OF FELLOWS DECEASED.

Dr. Hubert A. Newton, Professor of Mathematics in Yale University, whose death occurred on the 12th of August, 1896, was born in 1830, on the 19th of March, at Sherburne, in the State of New York. Both his parents were descended from ancestors who were among the first British settlers in Connecticut. His father built the Buffalo section of the Erie Canal, and it is recorded of his mother, whose maiden name was Butler, that she was remarkable for her mathematical attainments. He was one of ten children—seven sons and three daughters.

At school the lad showed the aptitude for mathematics, and especially for geometry, which distinguished him throughout his life. He entered Yale University at the age of 16, and graduated with the highest mathematical honours in 1850. After his graduation he continued for two and a half years more to devote himself to the study of advanced mathematics, at the expiration of which time he was, in 1853, appointed mathematical tutor in his university. Two years later, at the unusually early age of 25, he was elected to the full professorship, which he held through the rest of his life. In 1859 he married a daughter of the Rev. Joseph C. Stiles, who survived her husband only three months, leaving two daughters.

Professor Newton's life was one of great industry. He was Associate Editor of the 'American Journal of Science' for twenty-seven years, was a member and afterwards President of the Publishing Committee of the Connecticut Academy of Arts and Sciences, and, in addition to a long list of original memoirs, wrote articles for various cyclopædias, among others for the 'Encyclopædia Britannica.' He took an active part in promoting the introduction of metric measures into America, and on the Board of Management of the Yale Observatory, which owed its existence largely to the efforts and personal sacrifices of Professor Newton, and of which he was for a long time Secretary and for two years Director. He even took a part in municipal affairs, and it is characteristic of the esteem in which he was held, that it is recorded of him that he was elected alderman in a ward in which the prevailing politics were in opposition to his own. In 1875 he presided over the Mathematical Section of the American Association for the Advancement of Science, and in 1885 was President of the Association. At an early period he received the honorary degree of LL.D. from Michigan University, and in 1888 was

awarded the Smith Gold Medal of the American National Academy of Sciences, in recognition of his original work. In this country he was elected a Foreign Member of the Royal Society, of the Royal Astronomical Society, and of the Royal Society of Edinburgh.

The first of his papers seems to have been published in 1857, and the last, "On the Relation of the Plane of Jupiter's Orbit to the Mean Plane of 401 Minor Planets," in 1895. Between these dates he published a long series of papers—usually from two to four each year—covering a variety of subjects in mathematics, insurances, and especially in that branch of astronomy which relates to meteors and comets. These intimately connected phenomena early fixed his attention. His first paper in reference to them was published in 1860, and a continuous succession, nearly fifty in all, have been the result of his studies in this department of astronomy, and have contributed largely to the immense advance which the astronomy of meteors has made within the last forty years.

Two memoirs may be selected to illustrate how much modern science owes to Professor Newton's industry and clear insight. The first of these is his great memoir entitled "The Original Accounts of the Displays in former times of the November Star-shower: together with a Determination of the length of its Cycle, its Annual Period, and the probable Orbit of the Group of Bodies round the Sun." This memoir is published in the 'American Journal of Science' ('Silliman's Journal'), vols. 37 and 38 (1864). In it Professor Newton makes use of the collections of ancient records of star-showers which had been brought together chiefly by the great industry of French antiquarians and French astronomers. From these records Professor Newton traces out all which refer to former visits to the earth of that great swarm of small bodies which are now known as Leonids, but which, when first observed, radiated from the constellation Cancer. In each case he cites the actual words of the original records, of which there are usually several referring to each shower; and by a careful scrutiny of these he is able to fix, in many instances with certainty, in others with more or less probability, the actual date on which each shower occurred, and even in some cases the hours during which it lasted. He thus discovered that we possess records of thirteen showers of these meteors, of which the earliest was in A.D. 902, and the last (at the time when he wrote this memoir) was in 1833. To these we have now to add the two great displays witnessed from Europe in 1866, and from America in 1867.

By this careful scrutiny Professor Newton discovered several important facts—that the main swarm returns to the earth at intervals of 33·25 years; that on each return the earth encounters the dense part of the swarm in two consecutive years; that the date of the

principal showers has advanced at a nearly uniform rate from October 12, old style, which was the date in A.D. 902, to November 12, new style, which was the date in 1833; and finally that the meteoric orbit, whatever it is, is but little inclined to the ecliptic, and that the motion of the meteors where they enter the earth's atmosphere is nearly perpendicular to the direction of the sun.

Such being the facts, he proceeds to determine what inferences may be drawn from them. From the dates of the showers he ascertained that the node of the meteoric orbit—the point of its intersection with the earth's orbit—has been since A.D. 902 advancing in longitude nearly uniformly and at the average rate of 1·711′ annually. Allowing for the precession of the equinox, this is equivalent to an advance of 29′ in $33\frac{1}{4}$ years, measured from a fixed point. This motion is accordingly direct, and Professor Newton infers from this and from dynamical considerations that the motion of the meteors in their orbit must be retrograde. He next considers whether the meteoric orbit is wholly or only partly occupied by the dense swarm of meteors. He first examines the hypothesis of an elliptic orbit along which the meteors are distributed uniformly, and which suffers such perturbations that it shifts about so as periodically to intersect the earth's orbit three times in a century. He finds that this hypothesis must be rejected, because it involves an apsidal motion so rapid as would require perturbing forces of an intensity which we can satisfy ourselves do not exist. Accordingly the meteors, leaving out of account the sporadic meteors which have got separated from the main swarm, occupy only a portion of their orbit. He next inquires what further can be learned about an orbit of which the main swarm of meteors occupies only a portion; and he made the important discovery that only five orbits are compatible with the observed return of the swarm to the earth at intervals of $33\frac{1}{4}$ years. One of these five, accordingly, must be the true orbit. Professor Newton determined the periodic times in these orbits, and thus ascertained the axis major of each. All that was then wanting to fix the precise form and position of each of the five orbits was a sufficiently accurate determination of the "radiant point," *i.e.*, of that direction from which the meteors are seen to enter our atmosphere. On account of Professor Newton's representations, efforts were made by astronomers to make this observation with the utmost care during the great meteoric showers of 1866 and 1867. This direction, when corrected for the deflection of the meteors by the earth's attraction, furnishes the position in space of one tangent to the orbit. Knowing then the focus, the axis major, and the position and point of contact of one tangent of each of the five orbits, its exact form and situation in space can be ascertained. Thus the five orbits become fully known; and the next step was to determine which of them is the

actual orbit of the meteors. Professor Newton pointed out a line of investigation by which it was possible that this discrimination might be made. Bodies revolving round the sun in these several orbits would be differently acted upon by the surrounding planets. The perturbations in these five orbits would accordingly be different, and would probably lead to a different rate of shift of the node of the orbit along the plane of the ecliptic. If then, the perturbations in all the five orbits can be so fully investigated that the rate of the shift of the node in each can be computed, it will then be seen which of the five computed amounts accords with that which Professor Newton deduced from the observations, viz., an advance of 29′ in $33\frac{1}{4}$ years, or 50·2″ annually.

This was an invaluable suggestion, and the key to the complete solution of the problem, although there was at the time little hope that any mathematician could be found competent to grapple with the difficulties of the problem, which involved the investigation of a kind of perturbation which had never been attempted, viz., the perturbation by a planet of a body revolving in the reverse direction in an orbit round the sun, which is nearly coincident with the orbit of the planet. Fortunately our own Professor J. Couch Adams was able to cope with all the difficulties of the problem, and after five months' labour found himself in a position to make known which of the five orbits is the real orbit of the meteors. This marvellous achievement, however, would not have been possible without the discoveries that had been made by Professor Newton: 1st, of the amount of the average shift of the node; 2nd, of the fact that the choice lay between five orbits which he defined; and 3rd, that a discrimination between these was theoretically possible by the method afterwards successfully employed by Adams. Thus one of the most marvellous discoveries of the century in dynamical astronomy is due to the associated efforts of these two great men. Professor Newton indicated the problem and pointed out how it was to be attacked, and Professor Adams successfully grappled with its immense difficulty.

One other example of Professor Newton's contribution to our knowledge of astronomy must here suffice. It may be treated briefly. Most comets come into that portion of space which is occupied by the solar system from great distances outside. Such comets move either in parabolas, or in ellipses or hyperbolas which approximate to parabolas. By an examination of the orbits of 247 comets, Professor Newton establishes the fact that the planes of the orbits of these non-periodic comets lie in all positions indifferently, and that such comets exhibit no preponderance of direct over retrograde motion; whereas all the known periodic comets, which are about fifteen in number, move in planes which are but moderately inclined to the planes in which the principal planets move, and show such a marked

preponderance of direct over retrograde motion that only two have their motion retrograde, viz., Halley's comet and the comet associated with the great Leonid swarm of meteors.

Professor Newton succeeded in explaining this remarkable difference in behaviour of the two classes of comets. He shows that the preponderance of small inclinations and the preponderance of direct over retrograde motions would inevitably establish themselves amongst comets of short period, on the supposition that each of these is a comet of the other class which has at some time passed so close to a planet that it was drawn aside from its original orbit.

Laplace had shown that if a comet passes close to a planet the influence of the planet upon it may be found to a first approximation by drawing a sphere of a certain size round the planet, and supposing that the comet has moved in a parabola round the sun, undisturbed by the planet, until it passes inside the sphere; and that while inside the sphere it moves in a hyperbola relatively to the planet, attracted by the planet alone and unperturbed by the sun. This is equivalent to supposing that as a first approximation we may neglect the small difference between the direction and amount of the sun's attraction upon the comet and planet while the former is traversing the sphere from the point of its entrance into the sphere to its point of exit.

Professor Newton points out that if the comet passes in front of the planet as the planet advances along its orbit, then it will necessarily accelerate the planet and thereby increase the planet's kinetic energy. An equal amount of energy must be lost by the comet, of which therefore the speed relatively to the sun decreases; and therefore, if the orbit round the sun was a parabola before it entered the sphere of the planet's influence, it will start along an ellipse after emerging from that sphere. It thus becomes a member of the solar system. On the other hand, if the comet pass behind the planet the opposite effect is produced. The planet loses kinetic energy which the comet gains, so that the comet when it extricates itself from the sphere of the planet's influence, proceeds to move in a hyperbolic orbit round the sun, past which it can make but one sweep, and will then finally quit the solar system unless it encounter some other planet.

Professor Newton deals specially with the planet Jupiter. It is manifest that the only parabolic orbits which approach that planet are to be found amongst those of which the perihelion lies as near to the sun or nearer than the orbit of Jupiter. Professor Newton shows that out of 1,000,000,000 comets traversing the solar system in such orbits, about 839* will have their orbits changed by that

* From this number a small deduction, perhaps of some dozen or so, has to be made, to allow for those comets which actually collide with the planet.

planet into elliptic orbits with a periodic time less than that of Jupiter; and by a further scrutiny of the dynamical conditions he finds that moderate inclinations to the orbit of Jupiter will largely preponderate among the comets so affected, and that direct motions will preponderate over retrograde—thus explaining both these observed facts of nature. This remarkable investigation will be found in three papers, one in the 'American Journal of Science and Arts,' 3rd Series, vol. 16 (1878), and the other two in the Reports of the British Association for 1879 and 1891.

It is recorded of Professor Newton that he was noted in his own university for the special pleasure which he took in all mathematical investigations upon which geometrical insight could be made to bear; and it must strike every student of Professor Newton's published work that science in large measure owes the discoveries which he made to the clearness of his geometrical and dynamical conceptions, and to his facility in dealing with them.

This record ought not to close without referring to the circumstance that Professor Newton's original researches were the offspring of his leisure. He regarded the duties of his professorship as those of primary obligation upon him; to these he at all times first gave his full attention, and he seems to have possessed in a conspicuous degree the powers of imparting to the students who had the good fortune to be brought into contact with him a share of his own enthusiastic love of mathematics. The motives which impelled him to devote in addition the time which he felt to be at his own disposal to a search into the secrets of nature, are illustrated by words that he once used and which will find an echo in many minds:—"To discover some new truth in nature, even though it concerns the small things in the world, gives one of the purest pleasures in human experience, and it gives joy to tell others of the treasure found."

G. J. S.

Richard Quain, who died on March 13, 1898, at the age of 81, was born on October 30, 1816, at Mallow-on-the-Blackwater, co. Cork, in which county his family was one of the best known and most respected. His father, John Quain, was a younger brother of Richard Quain, of Ratheahy, whose sons, Jones and Richard, were distinguished for their knowledge of anatomy and surgery, and John Richard as a lawyer and judge in the Court of Queen's Bench. The father of the subject of this notice married, in 1815, Mary, daughter of Michael Burke, of Mallow, a member of an ancient and honoured Irish family.

After early education at Cloyne, Richard Quain was apprenticed to a medical practitioner in Limerick, where he acquired a knowledge of

many of the essentials of medical practice. In 1837 he entered the University College of London, where his two cousins were, the one Demonstrator, the other Professor of Descriptive and Practical Anatomy, from whom he seems to have received much sympathy and valuable instruction. In this School of Medicine he studied with much diligence, and his perseverance and keen powers of observation obtained for him many distinctions.

In 1840 he graduated as M.B. of the University of London, obtaining high honours in physiology, surgery, and midwifery. He continued to gain much experience in the appointments of Resident Surgeon or Physician at the hospital, and in 1842 he obtained the degree of M.D. at the London University, receiving a gold medal and certificate of special proficiency. He was soon afterwards elected a Fellow of University College.

In 1848 he became Assistant Physician to the Hospital for Diseases of the Chest, at Brompton, where he was associated with Drs. Walsh, Theophilus Thompson, and Cotton. In 1855 he was elected Physician to this hospital, and his connection with it as a Consulting Physician continued till the time of his death. He was also Consulting Physician to the Seamen's Hospital at Greenwich, and to the Consumption Hospital at Ventnor.

In 1851 Quain was elected a Fellow of the Royal College of Physicians, and was identified with it till the time of his death; for he was a member of the Council, Censor, Lumleian Lecturer, Senior Censor in 1877, Harveian Orator in 1885, and Vice-President in 1889. In 1888, on Sir William Jenner's retirement, he contested the Presidency with Sir Andrew Clark, who, however, was elected, though only by eight votes, in a large meeting.

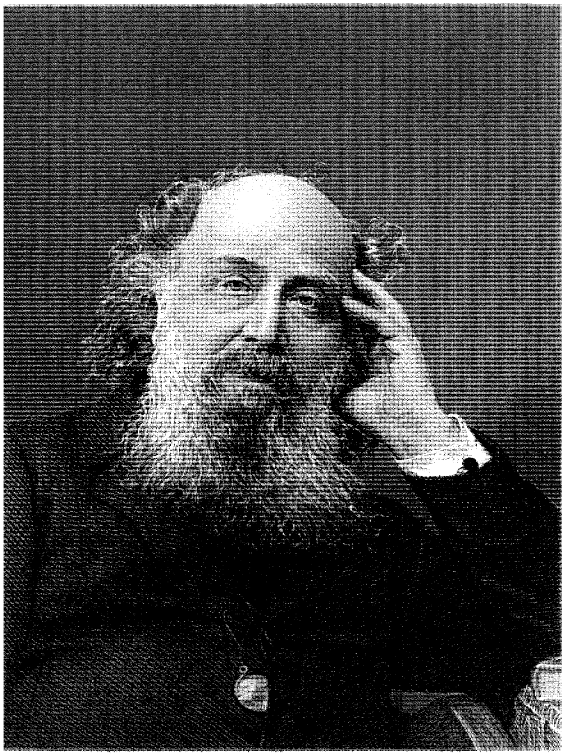
In 1863 Quain was elected as Crown nominee of the Medical Council, and continued in that post till his death. He was a moving spirit in all the work of that body; he was a member of many committees, serving with great distinction on the Pharmacopœia Committee, which he seemed to make his special care, though most active on several others. The services he rendered to this Council in the various offices he held were most valuable, and the result was his appointment, on the death of Mr. John Marshall in 1891, to the post of President, to which he was unanimously re-elected on the expiry of his first term of office in 1896, when he gave a valuable address, clearly setting forth the questions in which the Council were interested and his own practical and statesman-like view of the methods of dealing with them. His predecessors in this important office were Sir Benjamin Brodie, Joseph Henry Green, Sir George Burrows, Sir George Edward Paget, Sir Henry Acland, and John Marshall, none of them more devoted to the duties or more efficient as President of the Council than himself.

Sir Richard Quain's literary work and his researches into various departments of medical science were, if not numerous, very important. As a member of the Royal Commission appointed in 1865 to consider the question of rinderpest or cattle plague, in which he was associated with Lord Spencer, Lord Cranborne (now Marquess of Salisbury), Lord Sherbrook, Dr. Lyon (now Lord) Playfair, Dr. Edmund Parkes, and Dr. Bence Jones, he took a prominent part, and was an earnest advocate of the stamping-out measures recommended by the Commission, which, though strongly opposed at the time, subsequent events have proved to have had the result of saving large sums of money to the nation. He was a frequent contributor to the 'Saturday Review,' to the 'Lancet,' and other medical journals; whilst his treatise on "Fatty Degeneration of the Heart" in the 'Transactions of the Medical and Chirurgical Society' for 1850, expanded into a more elaborate article in his 'Dictionary of Medicine' some years later. His reports, in conjunction with the staff of the Brompton Hospital, compiled for several years, of the cases treated there; some valuable contributions to the 'Lancet' of 1845 on Bright's disease, and to the 'Edinburgh Monthly Journal of Medicine' on "Injuries of the Valves of the Heart," together with his Lumleian Lectures given before the College of Physicians in 1872 on "Diseases of the Muscular Walls of the Heart" were, and are still, regarded as authoritative writings.

But the great work with which Quain's name will ever be associated is that of the 'Dictionary of Medicine,' on which the years between 1875 and 1882 were spent, and which reappeared in a second edition in 1894, enlarged and brought up to the knowledge of the present time. For this cyclopædia of medical science he had carefully selected the contributors from the most eminent members of the medical profession, whose communications were all revised and, in some cases, modified by himself. His own contributions, especially those on "Fatty Degeneration of the Heart," "Angina Pectoris," "Aneurism of the Heart," "Diseases of the Bronchial Glands and General Remarks on Disease" are not the least valuable. The work, in short, having filled a want long felt by the profession, gained their entire confidence. To his able coadjutors, Dr. Frederick Roberts, Dr. Mitchell Bruce, and Mr. John Harold he gave due credit, and to their untiring devotion to the work its success is in great part—as he himself would have acknowledged—to be attributed.

Not the least interesting of Quain's contributions to medical literature was his Harveian Oration, delivered before the Royal College of Physicians in 1885, in which he dealt eloquently with the healing art in its historic and prophetic aspects.

In 1871 Dr. Quain was, for his eminence as a physician and for



James Joseph Sylvester

Engraved by G. J. Stodart from a Photograph by Mess.rs J. Hilliard & Co. Oxford.

scientific research into subjects connected with medicine, elected a Fellow of the Royal Society. He was also a member of the Senate of London University elected by the Queen, LL.D. of Edinburgh, M.D. (Hon.) of Dublin and of the Royal University of Ireland, and also a Fellow (Hon.) of the Royal College of Physicians of Ireland. He was Fellow and President of both the Medical and Chirurgical and the Pathological Societies, to the 'Transactions' of which he made several valuable contributions, and member and President of the Harveian Society of London.

In 1890 he was appointed Physician Extraordinary to the Queen; and on New Year's Day, 1891, received the well-merited honour of a baronetcy of the United Kingdom. This becomes extinct with his death, as Sir Richard Quain leaves no son. Isabella Agnes, Lady Quain, to whom he was married in 1854, was the only daughter of Mr. George Wray, of Cleasby, Yorkshire she died, to his profound grief, a few months after the baronetcy had been conferred upon him. Four daughters survive him.

Sir Richard Quain was much and justly esteemed by his profession and by the public. The kind-heartedness and geniality of his nature, his amusing and epigrammatic conversation, his wide knowledge of men, and his unwearying sympathy and kindness, made him popular not only with the younger as well as the older members of his profession, but with society generally, and in the Athenæum and Garrick Clubs, of which he was a well known member, whilst the bright and cheering effect of his presence in the sick room was always beneficial. Few men have been more endowed with the faculty of endearing themselves to their acquaintances, friends, and patients; and few will be more regretted than the warm-hearted, genial Irishman and physician who has been taken from us, though not until advanced age had afforded the world full opportunity of appreciating his merits.

J. F.

JAMES JOSEPH SYLVESTER was born in London on September 3, 1814. He was the youngest son of Abraham Joseph, and had five brothers and two sisters. His eldest brother early in life established himself in America, and assumed the name of Sylvester an example followed by all his brothers.

James went to Neumegen's well-known Jewish boarding school at Highgate from the age of six until he was twelve. Mr. Neumegen, a good mathematician, was strongly impressed by the boy's mathematical talent, sedulously fostered it, and sent him at the age of eleven to be tested by Dr. Olinthus Gregory at the Royal Military Academy at Woolwich. Dr. Gregory, after examining in algebra, pronounced him to be possessed of great talents, and recommended his mathematical tutor to pay great attention to his instruction. He

subsequently went to Mr. Daniell's school at Islington for a year and a half, where he came under Mr. Downes. Thence to London University for five months, and in 1829, being then fifteen years of age, he was sent to Liverpool. During this time Dr. Gregory kept up his interest in the boy, for, in March, 1827, he wrote to his father " Pray have the goodness to drop me a line so soon as your son returns home that I may endeavour to fix a day in which I may have the pleasure of seeing him here, and tracing his progress since I saw him before."

At about this period he was for a short time a pupil of De Morgan. At Liverpool he went to the Royal Institution,* which had itself been founded in 1814, and its school in 1819. He lived with his aunts, who had a school in Duke Street almost opposite Colquill Street at the corner of Cornwallis Street, the house then commonly known as "Morrell's Folly." One of his aunts was married to Elias Moxley, one of three brothers who represented Barnard's Bank in Lord Street. It appears from the school records that at a meeting of proprietors on the 12th February, 1830, Thomas Langton, Esq., president, Sylvester was awarded the prize in the second class as the result of the examination after the winter vacation. Other prize winners were William Robertson Sandbach, George Hancox, and Murray Gladstone. In regard to the mathematical prize secured by Sylvester, it is stated "In the Mathematical School one of the students, who had previous to entering it attained considerable proficiency, was so far advanced before the other scholars that he could not be included in any class; the first prize has without competition been awarded to him." At the presentation of prizes, Mr. Langton addressed him in the following words:—"In presenting to you, James Sylvester, the youngest of the successful students, the first prize for mathematical progress, let me caution you not to look upon it as an occasion of triumph; in receiving it you are giving a pledge of your future diligence in the improvement of those natural abilities with which a kind Providence has blessed you." The pupils of the school numbered but thirty. The Rev. T. W. Peile, B.A., Fellow of Trinity College, Cambridge (afterwards head master of Repton), was head master; William Moore, B.A., of Trinity College, Dublin, second master; and Mr. Marratt, mathematical master.

Few now remain who were with him at this school. Of these Sir William Leece Drinkwater, until quite recently first deemster, Isle of Man, perhaps knew him best, and I am indebted for many particulars to a letter which he has been good enough to write me. It does not

* Mr. John Forshaw, who went to the school shortly after Sylvester left, writes that the Mechanics' Institution, originally founded in 1825, has since been transformed into the Liverpool Institute, which must not be confused with the Liverpool Royal Institution standing about a quarter of a mile away in Colquill Street.

appear that Sylvester was in all cases kindly treated by his schoolfellows. He was kind-hearted and brave, but rendered extraordinarily irritable by the constant references, in a spirit of opposition, to his Jewish extraction. He fought many battles in defence of his religion with, it is said, greater courage than skill. On at least one occasion he wished to fight a duel, being aware that with fists he was no match for his opponent. At one time, considering that he was treated with oppression by one of the under-masters, and being directed, with the rest of the class, to write a theme on "Despotism," he composed an excellent essay, giving various instances, both high and low, of the abuse of power, but reflecting unmistakably upon the case of the under-master and himself. He concluded:—"Thus we see that power begets tyranny, whether in the case of the mightiest monarch or of the petty usher of a school or institution." The severe punishment that followed, it is related, was endured with great courage.

Soon after, Sylvester ran away from the school. He sailed from Liverpool, and shortly found himself in the streets of Dublin with but a few shillings in his pocket. This led to a singular incident. As the boy was walking down Sackville Street he was observed by an elderly gentleman who, his curiosity aroused, stopped and inquired into his circumstances. A few moments' conversation sufficed to reveal the fact that the boy was related to his wife, being, in fact, her first cousin! Thereupon he invited him to his house, entertained him, and finally sent him back to Liverpool. The gentleman was the Right Hon. R. Keatinge, Judge in the Prerogative Court of Ireland.

Being fully aware of his great knowledge of mathematics, he was in the habit of proposing questions beyond the capacity of the mathematical master. Before leaving he gained a prize of five hundred dollars offered from the United States for the solution of a certain question. It seems that a problem in combinations of great difficulty had come under the notice of a certain D. V. Gregory, a friend of Sylvester's elder brother in New York. On the advice of the latter it was sent to the younger brother in Liverpool, who almost immediately solved it. Its nature may be gathered from the subjoined extracts from a letter addressed to him a few years afterwards by D. V. Gregory:—"You solved my problems, which I submitted without their knowledge, to the great satisfaction of the Contractors of Lotteries in this country, and they expressed, frequently, an exalted opinion of your mathematical attainments in solving so intricate a subject. The inventor of the combination system himself was never able, as I learn, to package by any mathematical rule . . . On account of their withdrawing from business at the end of this year, the managers had prepared all

the necessary printing to complete their engagements, which printing was done according to the making up of packages by boys in our employ without any order or system or mathematical arrangement. This was a tedious process, and required some months' labour and consequent expense, and terminated in making a great number of miscellaneous packages containing a disproportion of numbers. Had your mathematical skill been known when they commenced business in 1823, or even five years after, and had they adopted your arrangement, they would have saved thousands of dollars expended by them in preparing for the printer."

Sylvester was less than two years at the Liverpool Institution. Afterwards he read for a few months with the Rev. Richard Wilson, D.D. (late Fellow of St. John's College, Cambridge), and then in 1831, at the age of seventeen, was entered at St. John's College, Cambridge. He came out first in his first year ; but in June, 1833, he became seriously ill and had to remain at home till November. He then returned to the University, but again unfortunately became ill in February, 1834, and was obliged to remain at home for nearly two years, not rejoining his college till January, 1836. In the following month he had the misfortune to break a blood-vessel. On recovering, he pursued his studies till January, 1837, when he came out Second Wrangler. Griffin was Senior of the year, and the list contained also the name of Green.

Being unwilling to sign the Thirty-nine Articles, he was unable to take a degree, to obtain a Fellowship, or to compete for one of the Smith's prizes.

At this time, on the occasion of laying the foundation stone of the Mechanics' Institution, Mount Street, Liverpool, Sylvester presented Lord Brougham with his pamphlet criticising Euclid's definition of a straight line as length without breadth. He also composed his first paper on "Fresnel's Optical Theory of Crystals," which appeared in vol. 11 of the 'Philosophical Magazine;' and on the death of Dr. Ritchie in the same year he became a candidate for the Chair of Natural Philosophy in the London University College. The testimonials which he received for that occasion are evidence of the high estimation in which he was held by tutors, examiners, and the other scientific men with whom he had been brought into contact. The list of his supporters includes the names of J. W. Heaviside (the Senior Moderator in 1837), S. Earnshaw (Senior Examiner), George Peacock, W. H. Miller, H. Philpot, J. Hymers, W. Hopkins, J. W. Colenso, P. Kelland, J. Bowstead, J. Cumming, Frederick Thackeray, James Hildyard, E. Bushby, Richard Wilson, J. Challis, and Olinthus Gregory. Evidently all these were aware that a star of the first magnitude was rising in the mathematical firmament. They seem particularly to have noticed his analytical power and command of

language, combined with originality and enthusiasm: qualities which were conspicuous throughout all his subsequent scientific career. It may be observed too that his interest was not confined to the subject of his greatest predilection, for whilst at Cambridge he attended regularly the chemical lectures of Cumming and the classical lectures of Bushby. This catholicity of taste, so early exhibited, is doubtless one reason for the brightness and freshness with which, throughout life, he could treat the dullest and most abstruse subjects.

He was appointed to the Chair at University College in the session 1837–38, his friend De Morgan holding the Chair of Pure Mathematics. He had some difficulty in drawing diagrams on the blackboard to illustrate his lectures. He was, in fact, never clever with his hands, his handwriting in particular being very bad. A curious instance of his constant desire to be thorough is brought to light by the circumstance that for some time after taking up the professorship he took lessons in drawing from the college drawing master; it is said, however, with small results. He published a remarkable series of papers in the 'Philosophical Magazine,' vols. 13 to 17, principally on matters connected with the Theory of Equations, Elimination, Sturm's Functions, &c., and laid the foundations of the work with which his name will ever be associated. He retired from University College in the session 1840–41, and immediately afterwards accepted the Professorship of Mathematics in the University of Virginia. For the due appreciation of matters that will be presently related, it should be stated that Sylvester at this period felt strongly on the subject of slavery, and was, moreover, in the habit of expressing himself thereon with great warmth. He was indeed antagonistic to oppression in all its forms.

In the United States 1840 was the presidential year. It was the eve of the introduction of new political methods. A new party was formed, with the platform "Absolute and unqualified divorce of the general government from slavery, and the restoration of equality of rights among men." Feeling ran high, particularly in Virginia, which was, later on, one of the Confederate States. Men of experience warned Sylvester that he should, on crossing the water, be guarded in his expressions, and refrain from hotly stating his opinions on the subject of slavery. He, however, determined to go, and, after sitting for a full length portrait in oils, by Patten, of the Royal Scottish Academy, now in possession of the family, he embarked at Liverpool in a Cunard sailing vessel. The portrait is evidently the work of a good painter, and is stated to be an excellent likeness. It represents a young man of six and twenty, in cap and gown, with dark, curly hair, and spectacles, seated, book in hand, at a table.

In America he appears to have been at war with his surroundings from the first. He found nothing sympathetic or inspiring, and the cause of his exit from the country after six months arose from an unfortunate incident with two students in his own class.

For two or three years after his return from Virginia he appears to have done little work. As remarked by Dr. Halsted there were distinct periods of his life during which he felt much discouraged, and seemed to have no heart for mathematical research.

In 1844 activity recommenced. He was elected to the post of Actuary to the Legal and Equitable Life Assurance Company. This was a responsible post, particularly at that time when, through mismanagement, one of the principal establishments in England had been brought to the brink of ruin. He made constant valuations and acted as check officer and scientific adviser to the directors of this and some other companies for many years, residing for the greater part of the time at 28, Lincoln's Inn Fields. He also accomplished an extraordinary amount of mathematical research. A few titles of the papers now published during this time will give a general idea of the subjects which principally occupied his mind:—"On the Dialytic Method of Elimination," "Elementary Researches on the Analysis of Combinatorial Aggregation," "On a discovery in the Theory of Numbers relative to the Equation $Ax^3+By^3+Cz^3 = Dxyz$," "On the Rotation of a Body about a Fixed Point," "Sketch of a Memoir on Elimination, Transformation, and Canonical Forms," "On the Principles of the Calculus of Forms," "On the Expressions for the Quotients which appear in the Applications of Sturm's Method to the discovery of the real Roots of an Equation." A number of these papers refer to the subject now known as the theory of invariants. It rose from its foundations, which had been partially laid by Boole in 1844, under the strong hands of Cayley and Sylvester. The conception of the problem and much of its orderly development may be ascribed to the former, whilst nearly the whole of the nomenclature and a great deal that is now recognised as being of capital importance, both as regards initiation and brilliant extension, is due to the latter. During the decade from 1845 he established his position as one of the foremost mathematicians of Europe. He had the friendship and esteem of such men on the continent of Europe as Lejeune-Dirichlet, Poncelet, Borchardt, Duhamel, Bertrand, Serret, Hermite, Otto Hesse, Peters, Kummer, Richelot, Joachimsthal, Chasles, with many of whom his correspondence was frequent and voluminous. The contemporaries in his own country—William Rowan Hamilton, Ivory, De Morgan, Graves, MacCullagh, John Herschel, Babbage, Donkin, Challis, Kelland, Salmon, William Thomson, and others—also testified on occasions that they were aware a great mathematical genius had

appeared in the ranks of scientific men, and was rapidly forcing his way to the front.

In 1854, on the death of W. M. Christie, Sylvester was a candidate for the Professorship of Mathematics at the Royal Military Academy at Woolwich. Christie had been professor since 1838, preceded by Gregory, 1821–38; Bonnycastle, 1807–21; Hutton, 1773–1807; Cowley, 1761–1773; Simpson, 1743–1761.

Leading mathematicians at home and abroad testified to his eminence and fitness for the appointment, but, as shown by the subjoined letter, he was not successful:—

"From Lieut.-Colonel Portlock,
"Royal Military Academy, Woolwich,
"1st August, 1854.

"Sir,

"I am directed by the Lieutenant-Governor, Major-General Lewis, C.B., to notify to you that the Lieutenant-General of the Ordnance has selected the Rev. Matthew O'Brien to succeed Mr. Christie as Professor of Mathematics in this establishment.

"In making this notification, I feel it due to you to state that the great weight of your claim as a candidate was felt and recognised.

"I have the honour to be,
"Sir,
"Your obedient servant,
"J. PORTLOCK,
"Lieut.-Col. Inspector."

"J. J. SYLVESTER, Esq."

Owing to the destructive fire of 1873 there is now no record of this letter in the archives of the academy.

One cannot help recalling the rejection by the same establishment, a century before, of the celebrated Benjamin Robins, Copley medallist of the Royal Society, in favour of a Mr. Müller.

Mr. O'Brien was known as a fair mathematician, and had previously held the post of Lecturer on Physical Science. He did not take up the appointment, as a few months after his election his death occurred, when Sylvester was elected. In the interval, however, he sought, but did not obtain, election to the vacant Professorship of Geometry in Gresham College, and delivered a probationary lecture on geometry before the Gresham Committee on December 4, 1854. The lecture was printed, and in the preface occur the following characteristic remarks:—"The author will only so far forestall the arrival of the period (*quod longum absit!*) above alluded to by protesting against the use of the word 'practical' as employed by an ingenious lecturer who succeeded him at the desk. To discourse fluently on things of practice is no suffi-

cient evidence in itself of a practical mind. The first rule of practice is to do all things at the right time and in their proper places; to proportion the means to the ends and the ends to the means; above all to know what is possible, and to confine one's endeavours within the limits of the feasible. The author allows, and has habitually acted on the principle, that for the purpose of *illustrating* lectures on geometry or any other abstract science, the lecturer should lay his hands on the plough, the loom, the forge, the workshop, the mine, the sea, the stars, all things on earth or under heaven which may help to arouse the attention or interest the imagination of his auditors. But to profess to make the mere applications of a science such as geometry the staple of the matter to be taught within the walls of the college by the Gresham lecturer, to undertake to comprise within a course of geometrical lectures systematic instruction in mechanics, astronomy and navigation, descriptive geometry, engineering and drawing, the method of interpolation, the theory of toothed wheels, the two kinds of perspective, machinery, mapping, the art of shipbuilding, rules for cutting the best form of screws, and for enabling the citizens of London to qualify themselves for being their own land surveyors, is a suggestion which, with all due deference to its propounder, the author regards as one of the wildest and most visionary which ever entered into the mind or issued from the lips of a practical man." The address, composed at short notice, is a powerful essay on geometrical science.

He took up the appointment of Professor of Mathematics and Lecturer in Natural Philosophy at the Royal Military Academy on the 15th September, 1855. In August, 1856, the lectureship was taken over by the Professor of Practical Astronomy. The salary of the appointment was £550 per annum combined with a Government residence, medical attendance, and right of pasturage on the common. He occupied K Quarters, Woolwich Common, being the last of a long list of residential professors. The house was commodious and with a good garden. There he frequently entertained his friends from London and distinguished foreign mathematicians. At the same time he always had chambers in London in the neighbourhood of the Athenæum Club. These he had taken originally with the intention to practise at the Bar. Scientifically this was a glorious period for Sylvester, for, seated under a walnut tree which grew in the centre of his garden, he made some of the great discoveries with which his name will be for ever associated. He wrote about eighty papers, and naturally it is only possible here to glance at a few of those which are of fundamental importance. During 1857–58 he published remarkable advances in the theory of the Partition of Numbers, and in 1859 delivered seven lectures on the subject at King's College, London. The outlines of these dis-

courses have this year (1897) been published for the first time by the London Mathematical Society; they have attracted considerable attention, and have already led to a remarkable paper by Mr. G. B. Matthews, F.R.S.

In these researches Sylvester, standing upon the shoulders of Cauchy, showed how to form an algebraical expression, involving the imaginary roots of unity of different orders for the general coefficient in the associated generating function. It was a piece of analytical skill that could only have proceeded from a mind endowed with imagination of the highest order.

In 1864 appeared in the 'Philosophical Transactions of the Royal Society' a paper which will perhaps be considered his greatest achievement. The title is "Algebraical Researches: containing a Disquisition on Newton's Rule for the Discovery of Imaginary Roots, and an allied Rule applicable to a particular class of Equations, together with a complete Invariantive Determination of the Character of the Roots of the General Equation of the Fifth Degree, &c." Newton had given in the 'Arithmetica Universalis' a rule for discovering an inferior limit to the number of imaginary roots in an equation of any degree, but without proof or indication of method or marshalling of evidence. Maclaurin, Campbell, Euler, and Waring had also treated the question, but either failed to obtain a solution or had fallen into serious error in the attempt. Sylvester's memoir, described by him as a Trilogy, falls into three parts; in the first he establishes Newton's rule in regard to algebraical equations as far as the fifth degree inclusive; in the second he obtains a rule applicable to equations of the form

$$\Sigma(ax+b)^m = 0,$$

m being any positive integer, and a, b real coefficients; in the third he determines the absolute invariantive criteria for ascertaining the exact number of real and imaginary roots appertaining to an equation of the fifth degree. Here, as in his treatment of the Partitions of Numbers, he has frequently resorted to geometrical intuition. In the present investigation every superlinear function is conceived to be in association with a pencil of rays constructed in a definite manner, and much of the argument is given in the language of the geometry of pencils. During a conversation with the writer in the last weeks of his life, Sylvester remarked as curious that notwithstanding he had always considered the bent of his mind to be rather analytical than geometrical, he found in nearly every case that the solution of an analytical problem turned upon some quite simple geometrical notion, and that he was never satisfied until he could present the argument in geometrical language.

During these years he continually wrote upon the theory of inva-

riants, making important additions to it. The facility with which he associated subjects the most diverse is evidenced by the titles of some of his papers. Thus, "Thoughts on Inverse Orthogonal Matrices, Simultaneous Sign Successions, and Tessellated Pavements in two or more Colours, with Applications to Newton's Rule, Ornamental Tile Work, and the Theory of Numbers;" and "Astronomical Prolusions, commencing with an Instantaneous Proof of Lambert's and Euler's Theorems, and modulating through the Construction of the Orbit of a Heavenly Body from two Heliocentric Distances, the Subtended Chord, and the Periodic Time, and the Focal Theory of Cartesian Ovals, into a Discussion of Motion in a Circle and its Relation to Planetary Motion."

Particular events occurred during this period, which should be mentioned. About the year 1855 the 'Quarterly Journal of Mathematics' was founded, and Sylvester, who took a chief part as Editor, was anxious to have a suitable motto for the title page. He consulted many of his friends on the matter, De Morgan amongst others, and finally, after much correspondence, selected the following:—

> "*ὅ τι οὐσία πρὸς γένεσιν, ἐπιστημὴ πρὸς πίστιν*
> *καὶ διάνοια πρὸς εἰκασιαν ἔστι.*"

This motto appeared upon the title-page during the whole time that he was editor. The trouble he took in this matter is evidence of his interest in things which may appear trivial to others, but which, being important in his own eyes, he spared no effort to accomplish successfully. His mathematical correspondence was of wide range, and with De Morgan, Cayley, Salmon, Hermite, and Chasles he exchanged letters continuously. Cayley for a long time resided at 2, Stone Buildings, Lincoln's Inn, and frequently met Sylvester; indeed, they were in the habit of taking long walks, Cayley walking from London and Sylvester from Woolwich, meeting near Lewisham. It is certain that some of the fruits of these long consultations are before the world to-day.

It cannot be said that he was a great success at Woolwich as a teacher, being too far beyond his pupils who, for the most part, regarded mathematics as an irksome duty. He had the reputation of being eccentric and irritable. When not actually engaged in teaching, the mind of Sylvester would occasionally become abstracted from earthly affairs, and it is stated that on one occasion he suddenly looked up from a paper in the hall of study and demanded of the corporal on duty, "What year is it?" An explosion of laughter in the room led to a "scene," and the subsequent infliction of many punishments upon the cadets.

The sight of Sylvester leaving his house pursued by his landlady carrying his collar and necktie is said to have been not an unusual

one. He came into collision on more than one occasion with the authorities at the Academy and with the War Office. The culmination of these disputes was in 1870, when a War Office enactment, abolishing the separate offices of Professor of Mathematics and Professor of Mechanics, coupled with a limit of age for the new appointment, forced him to retire. At first it was the intention to make him leave without a pension, but, through the strenuous exertions of his friends in and out of Parliament, it was finally determined to grant him an annuity calculated in some proportion to the salary he had been receiving. Sylvester was consulted as to the assessment, and characteristically insisted that account should be taken of the value to him of his government residence, medical attendance, and right of pasturage on the common.

The pension was fixed at nearly £300 per annum. He had at least one enthusiastic fellow-worker during the time he was at the establishment, Mr. (now Sir Andrew) Noble, who collaborated with him in an important degree in the papers on the Theory of Partitions.

The London Mathematical Society was founded in 1864, with De Morgan as president, a post in which Sylvester succeeded him. In June, 1865, he delivered a lecture in King's College, London, "On an Elementary Proof and Generalisation of Sir Isaac Newton's hitherto undemonstrated Rule for the Discovery of Imaginary Roots."

In 1869 he was President of the Mathematical and Physical Section of the British Association for the Advancement of Science at Exeter, the meeting being under the presidency of Stokes. His address was largely a defence of mathematics from a statement that had recently been made by Huxley in a 'Fortnightly Review' article. The latter had written, "Mathematics is that study which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation." Sylvester put in a powerful and eloquent plea for the science as one unceasingly calling forth the faculties of observation and comparison, and affording a boundless scope for the exercise of the highest efforts of imagination and invention. Those engaged in this science know the truth of Sylvester's words, but it must be admitted that men of the highest eminence in other branches of science frequently are unacquainted with the real nature of the life work of a man like Sylvester, and of that inner world of thought where the phenomena require as close attention as those which present themselves in the outer physical world. Sylvester was a philosopher, and was well able to take a survey of all the sciences. While never underrating the importance of any of the recognised divisions, he saw the intrinsic beauty of that which he loved beyond all others, and no one was more competent to repel assaults upon it, and, it may be added, no one could have been more successful in doing

so. His enthusiasm, combined with his power over the English language, made him an opponent worthy of any controversialist living. The remainder of the address was on space conceptions, and mathematics as the science of continuity. In one sentence he stated: "It is very common, not to say universal, with English writers, even such authorised ones as Whewell, Lewes, or Herbert Spencer, to refer to Kant's doctrine as affirming space to be a "form of thought, or of the understanding." This led to an interesting controversy, in the columns of 'Nature,' between G. H. Lewes, T. H. Huxley, C. M. Ingleby, G. Croom Robertson, W. H. Stanley Monck, and, of course, Sylvester himself. The correspondence, with many critical notes, will be found in an appendix to Sylvester's 'Laws of Verse' (Longmans, Green and Co., 1870).

It is doubtful if Sylvester's reputation was ever higher than at this time. The recognition of his great talents, the appreciation of his transcendent genius, and the knowledge of the inspiring effect of his personality were universal. Foreign scientific academies had showered their honours upon him. Eminent men of all countries knew him personally. A mere recital of his academic distinctions would take up too much space. It can be found in any official list of the Fellows of the Royal Society.

On leaving Woolwich Academy in 1870 he lived near the Athenæum, and for a few years his mathematical activity was in abeyance. He had some idea of becoming a candidate for the London School Board, and addressed several meetings of working-men and other assemblages of electors in London. On these occasions he would occasionally sing to contribute to the merriment o the evening. Such old English songs as "Simon the Cellarer" were his favourite pieces. He also frequently recited at penny readings. In 'The Gentleman's Magazine' for February, 1871, there appears 'The Ballad of Sir John de Courcy,' translated from the German by Syzygeticus. He recited this versified translation at the New Quebec Club and Institute at a reading on April 11, 1879.

In 1874 he entered the lists again. The occasion was the wonderful discovery by Peaucellier of the straight line link-motion associated with his name. Sylvester soon made additions and generalisations, and finally gave a Friday evening discourse on the subject at the Royal Institution of Great Britain. He showed amongst other things of great interest how to construct a link-work of seventy-eight bars to solve the following problem:—"Required to construct a link-work fixed or centred at two of its points, such that (when the machine is set in motion) some other point or points therein shall be compelled to move in the line of centres."

He wrote several papers on the subject, one of them bearing the characteristic title:—"Mode of construction and properties of a new

sort of lady's fan, and on the expression of the curves generated by any given system whatever of link-work under the form of an irreducible determinant."

He invented the plagiograph *aliter* skew pantigraph.

A synopsis only of the Royal Institution lecture was published. The manuscript of the lecture as actually delivered is in the possession of George Bruce Halstead, of the University of Texas. Extracts from it appear in the American journal 'Science,' of April 16, 1897, from which it appears that it was characterised by that eloquence, force, and poetical imagination with which students of Sylvester are familiar.

In 1875 the Johns Hopkins University, at Baltimore, was founded, and the Trustees sought the advice of the president, Daniel C. Gilman, in the selection of the professorial staff. He replied "Enlist a great mathematician and a distinguished Grecian; your problem will be solved. Such men can teach in a dwelling-house as well as in a palace. Part of the apparatus they will bring; part we will furnish. Other teachers will follow them." Joseph Henry also advised that liberal salaries should be paid and the best men in the world secured. He brought Sylvester's name prominently forward, and finally the latter was offered the post of Professor of Mathematics. He demanded a higher salary than that offered, and this being granted he finally stipulated that his travelling expenses and annual stipend of 5000 dollars should be paid in gold, and then for the second time left England to take up a professorship in the United States.

He found the conditions ideal. While not being overburdened with routine work, he was surrounded by able assistants and talented pupils only too eager to aid him in his profound original work or to catch inspiration from his lips. The mathematical staff was indeed very strong, including men of such capacity as Thomas Craig, W. E. Story, and Fabian Franklin. Sylvester's first high class consisted of but one student, G. B. Halsted. This gentleman, since well known in science, had the most beneficial effect upon his master, for it was owing to his enthusiasm and persistence that Sylvester's attention was again called to the Modern Higher Algebra and the Theory of Invariants, and a fruitful crop of new discoveries was almost the immediate result. Others, including Franklin, Durfee, Ely, and Hammond in England joined in the investigations; a school of mathematics was founded; and the American renaissance in mathematics was an accomplished fact.

Shortly after joining at Baltimore, the University founded the 'American Journal of Mathematics,' with Sylvester as editor; and its pages are evidence of the activity of the new school. In five years Sylvester himself contributed thirty papers; some of great length. They are concerned chiefly with Modern Algebra, various points in

the Theory of Numbers, the Theory of Partitions, and Universal Algebra. A splendid record for five years.

His address before the University, on Commemoration Day, February 22, 1877, was most eloquent, and had an extraordinary effect upon his hearers, amongst whom was James Russell Lowell. After some remarks concerning the work of the University and his own share therein, he discoursed upon the difficulty created by the contending claims of teacher and investigator. He said that the solution lay in the never-to-be-forgotten words, which had recently been addressed to him, "The University desires from you your best and highest work." He went on to observe on the religious and other disabilities under which students in English universities had suffered, and brought into contrast the freedom in American and German universities. He spoke with as much warmth as power for, as he said, the subject came home to him. For some time he held his audience spell-bound. His speech was never finer than when under the influence of passion, and he abandoned himself to a torrent of words. Those competent to form an opinion believe that there was within him the material of a great orator.

The following remarks by some of his pupils in Baltimore are of interest as showing his character and method of lecturing.

Dr. E. W. Davis states :—

"Sylvester's methods! he had none. 'Three lectures will be delivered on a New Universal Algebra,' he would say; then 'the course must be extended to twelve.' It did last all the rest of that year. The following year the course was to be 'Substitution Theory, by Netto.' We all got the text. He lectured about three times, following the text closely, but stopping sharp at the end of the hour. Then he began to think about Matrices again. 'I must give one lecture a week on these,' he said. He could not confine himself to the hour nor to the one lecture a week. Two weeks passed and Netto was forgotten entirely and never mentioned again."

Mr. A. S. Hathaway says :—

"I can see him now, with his white beard and few locks of grey hair, his forehead wrinkled o'er with thoughts, writing rapidly his figures and formulæ on the board, sometimes explaining as he wrote while we, his listeners, caught the reflected sounds from the board. But stop, something is not right; he pauses, his hand goes to his forehead to help his thought; he goes over the work again, emphasizes the leading points, and finally discovers his difficulty. Perhaps it is some error in his figures, perhaps an oversight in the reasoning. Sometimes, however, the difficulty is not elucidated, and then there is not much to the rest of the lecture. But at the next lecture we would hear of some new discovery that was the outcome of that difficulty, and of some article for the journal that he had

begun. If a text-book had been taken up at the beginning, with the intention of following it, that text-book was most likely doomed to oblivion for the rest of the term, or until the class had been made listeners to every new thought and principle that had sprung from the laboratory of his mind, in consequence of that first difficulty. Other difficulties would soon appear, so that no text-book could last more than half the term. In this way the class listened to almost all of the work that subsequently appeared in the journal. It seemed to be the quality of his mind that he must adhere to one subject. He would think about it, talk about it to his class, and finally write about it for the journal. The merest accident might start him, but, once started, every moment, every thought was given to it, and, as much as possible, he read what others had done in the same direction; but this last seemed to be his weak point; he could not read without meeting difficulties in the way of understanding the author. Thus, often his own work reproduced what others had done, and he did not find it out until too late."

Dr. W. P. Durfee, Professor of Mathematics at Hobart College, Geneva, N.Y., has written :—

"His manner of lecturing was highly rhetorical and elocutionary. When about to enunciate an important or remarkable statement he would draw himself up till he stood on the very tips of his toes, and in deep tones thunder out his sentences. He preached at us at such times, and not infrequently he wound up by quoting a few lines of poetry to impress upon us the importance of what he had been declaring."

On the death of H. J. S. Smith, Sylvester was elected to the Savilian Professorship of Geometry at Oxford, and in December, 1883, he finally left Baltimore to enter upon residence in New College, Oxford. At the time his mind was occupied with the theory of a new species of invariants; these are differential and of more immediate application to geometry than those of pure algebra. Sophus Lie had treated the whole subject of differential invariants from a general point of view, and had given the various categories, but had made no attempt to develop the special case treated by Sylvester. His notice appears to have been first attracted to the subject by the well-known invariantive property of the differential expression known as the Schwarzian Derivative, which in this country had been studied by Cayley and Forsyth. The invariantive forms, he quickly reached, he termed reciprocants, the name arising from the fact that, from his original point of view, the expressions arrived at were unchanged, to a *factor près*, by the simple interchange of the dependent and independent variables. Later he considered the general linear and homographic transformations applied to similar forms, and propounded an extensive theory of great geometrical

importance. The lectures on the theory were delivered before the University of Oxford during the Hilary, Easter, and Michaelmas terms of 1886, and subsequently published in the 'American Journal of Mathematics.' The powerful weapon chiefly employed in the research is due to the author himself, and is termed by him "the method of infinitesimal variation.' In many details, and in the orderly exposition, he was greatly assisted by James Hammond, M.A., and his fellow-workers in Oxford—E. B. Elliott, C. Laudesdorf, and L. J. Rogers—and others outside the University also made notable contributions. In particular, L. J. Rogers made a capital discovery in the Theory of Principiants (the name given to those reciprocants which are invariantive in respect of the homographic substitutions), which gave Sylvester material for most of the lectures in the latter half of the series.

This theory was Sylvester's last great work. A masterly contraction of Tchebicheff's limits with regard to the number of primes occurring between given numbers, and a tract upon Buffon's problem of the needle, are the only other papers that need mention.

Failing health, frequently involving acute suffering, came upon him when he was close upon eighty years of age. His high sense of the duties appertaining to his position would not allow him longer to attempt actively to lead the mathematical studies of the University, and in 1893 a deputy professor (Mr. W. Esson, F.R.S.) was appointed.

The remaining three years witnessed the gradual breaking up of an iron constitution. He lived for the most part with friends, or in apartments in or near Mayfair, with occasional visits to Tunbridge Wells, where he stayed at the Spa Hotel. For some years he was quite unable to think of mathematical subjects. He found that he could no longer understand notes that he had made in former years, and this made him sad and dejected. About August, 1896, a revival of energy and mental power took place, and till his death, March 15, 1897, he worked continuously at the Theory of Compound Partition, and made an heroic attempt to prove or disprove the celebrated Goldbach-Euler conjecture concerning the partition of every even number into two primes. A fortnight before his death, while working in his sitting-room at Hertford Street, Mayfair, he dropped his pen, and on stooping to pick it up had a paralytic seizure. He never spoke again, and continuously sank until the end came.

He was a Royal Medallist of 1861, and the Copley Medallist of 1880.

While it is certain that he was one of the greatest mathematicians of all time, it may be doubted whether he will take a place amongst the small band who occupy absolutely the front line. His character and temperament militated against continuity of thought. He would

be oppressed with a flood of ideas, which made it difficult for him to suitably organise his researches. A theory, half composed, would be forsaken that he might grapple with fresh imaginations. It is certain that but a small fraction of his best work has been published for the benefit of posterity. His genius and his greatness are not properly represented by the memoirs which he has left. He had, to some extent, the poetic faculty, and occasionally occupied himself with the composition of sonnets, both in English and Latin.

He had literary power, and considerable knowledge of languages, living and dead. He wrote French with ease, and conversed readily in French, German, and Italian. He was acquainted with both Latin and Greek, and when past seventy-five years of age read 'Athenæus' without a dictionary.

The writer, who had numerous opportunities of studying the character of this illustrious man in the last years of his life, when he was heroically battling against acute suffering, consequent upon the infirmities of extreme old age, formed the conviction, that will never be shaken, that his personal character was one of singular beauty, and that its salient points were simplicity and honesty. Absolutely and fearlessly honest from cradle to grave. Future generations will mark with admiration the deep footprints he has left upon the sands of time, but they will not be able to realise the effect which contact with his great spirit had upon his contemporaries, who knew and loved him. The superficial crust of eccentricities and slight faults of temperament once pierced, and the kernel of his nature reached, there was found a roundness and perfection of disposition that is not often met with.

It cannot, perhaps, be said that his religious convictions were of a kind which could be completely defined, but it is certain that he believed in a Supreme Being, and in a future life, a life full of enhanced intellectual power, and opportunities of intellectual growth. The atheist will find nothing to give him satisfaction in the story of this life, throughout which the faith was strong, and the conviction that high principle should be paramount always present.

His last sufferings, extending over fifteen days, were borne with fortitude.

So passed away one of the great spirits of the century.

"And he is gathered to the Kings of Thought."

P. A. M.

Alfred Louis Olivier Le Grand Des Cloizeaux, who died on May 6, 1897, in the eightieth year of his age, was born at Beauvais, Département de l'Oise, on October 17, 1817, and belonged to an old magisterial family. He was educated at Paris, and the teacher to

whom he went for instruction in "special mathematics" was the crystallographer Lévy: by him the young Des Cloizeaux was initiated into the mysteries of that science, and was advised to enter upon the mineralogical course then being given by Dufrénoy, at the École des Mines. At that institution he later made the acquaintance of Sénarmont, through whose influence it was that he afterwards came to devote himself so closely to the optical investigation of crystals. His first paper dealt with the crystallisation of Æschynite, and appeared in 1842; for the next half-century scarcely a year passed without the issue of one or more papers recording the results of some mineralogical research. In 1843 he was appointed Répétiteur at the École Centrale, and in 1857 Maître des Conférences at the École Normale; from 1873 to 1876 he took the place of Delafosse at the Sorbonne, and, on the retirement of that professor from his office at the Paris Natural History Museum, Des Cloizeaux was appointed (1876) to the Curatorship of that important mineral collection. This office was particularly congenial to his tastes, for he was always more happy in the laboratory than in the lecture-room; he retained it till 1892, when the rules of the Civil Service necessitated his retirement at the age of seventy-five.

Though his life-work related almost wholly to the morphology and optics of crystals, his inquiries were not limited to the examination of museum specimens; he was much interested in modes of origin and of occurrence, and in the geological relations of minerals; and he was always ready to seek an opportunity for seeing in its native home any mineral to the determination of the characters of which he had been devoting his attention. He went on two missions to Iceland (1845–6) to investigate the mode of occurrence of the well-known spar, about the scarcity of which physicists had already become anxious, and he brought back from that island many specimens of its minerals and rocks useful to him in his later researches; in 1868 he was sent on another special mission, on this occasion to Norway, Sweden, and Russia; and in the course of a long life he found it practicable to visit all the more important mineral localities of the Continent.

Two characteristics specially manifest in the work of Professor Des Cloizeaux are accuracy and perseverance: he would spare no pains to obtain the best values for the crystallographic constants of the material he was investigating, while, a problem once started upon, he would persist in its investigation for years, and return to it again and again as new specimens or new methods became available. For the first twelve or thirteen years his work was almost wholly morphological, and consisted in the determination of the crystallographic constants of rare or new specimens and in the description of the minerals associated together at new localities. To this epoch belongs his memoir on the crystallisation of quartz; to the thirty-

five then known forms of this common mineral he added no fewer that 135 new ones, many of them with complicated indices determined through the skilful use of zones: as to the remarkable stereographic projection prepared by Des Cloizeaux to illustrate the observed forms of quartz, Professor Ruskin, speaking as an artist and critic, has more than once expressed to the present writer his great admiration of the "patient labour and entire accuracy of workmanship" therein displayed.

From 1855 onwards his researches were mainly optical. It must be remembered that at the time when M. Des Cloizeaux entered upon the study of minerals, the instrumental appliances for the optical examination of small crystals were in the rudimentary stage of development, and were scarcely in use outside physical laboratories. He improved the polarising microscope of Nörremberg, giving it a new form, increasing the field of view, and making it a convenient instrument for the examination of small sections. Thereupon, not only did he entertain the colossal idea of determining the optical characters of all known crystals, whether natural or artificial, but he began the work. He was soon led to emphasise the importance of the "optical sign" for the discrimination of minerals, and in his determination of the crystallographic system to make constant use of the peculiarities of the distribution of colour in the rings afforded by the sections of crystals in convergent polarised light. In 1868 he published his observations of the changes of optic axial angle resulting from changes of temperature. In the case of orthoclase he found that, with a maximum temperature of 400° C. only temporary changes were induced, but that with a temperature exceeding 700—800° permanent changes resulted. Further, he pointed out that in the case of orthoclase from some volcanic rocks this changed optical condition was already a character of the specimens.

He was the discoverer of the circular polarisation of cinnabar, and showed that it was seventeen times that of quartz. He was the first to find a substance (strychnine sulphate) which rotates the plane of polarisation, both in the crystallised state and in solution. He showed that benzil circularly polarises when in crystals, but is inactive when fused or in solution, and that, on the other hand, camphors are active only when in solution. He was the first to show, by optical characters, that there are ortho-rhombic members of the epidote, pyroxene, and amphibole groups, and that the three types of humite have characteristic optical features.

But more especially was he interested in the felspars, a group of minerals of fundamental importance in the classification of rocks, and to the investigation of which he gave more than twenty years of his life. When he began this work it seemed unlikely that much was left to be discovered in the case of so long known a group, and

it was a veritable triumph for his method of work that he was able to establish that there was a kind of potash-felspar distinct from orthoclase; it was anorthic instead of mono-symmetric in its symmetry, although approximating to the latter in the development of its forms, and its optical characters, instead of being unstable, are stable at all temperatures; to this he applied the term microcline. Indeed, it is to Des Cloizeaux that we owe our first precise knowledge of the optical characters of all the plagioclastic felspars, and the determination presented constant difficulty to him by reason of the lowness of the symmetry and the smallness and rarity of well-developed crystals.

Much of his work has been incorporated in the treatise to which he gave the modest title 'Manuel de Minéralogie,' and which is now the standard book of reference for all that relates to the optics of minerals. In its compactness and freedom from unnecessary words, and indeed in its general characters, it bears a close resemblance to (Brooke and) Miller's edition of 'Phillips's Mineralogy'; and it is interesting to know that at first he had intended merely to translate that book, but was eventually compelled, by the extension of his optical researches, to prepare an independent treatise. He adopted the same general plan in giving a stereographic projection of the observed faces for all the more important minerals, and elaborate lists of measured and calculated angles useful in the recognition of the substance. The preparation of this manual was a work of great labour, and involved a vast amount of physical observation and numerical calculation; he made it a rule never to cite an angle without verification by observation or recalculation. The first volume of the manual was published in 1862; the first part of the second volume in 1874, and the second part in 1893. The third and last volume had not been issued at the time of his death, but is now being prepared for publication by his successor at the Museum and former pupil, Professor Lacroix.

Professor Des Cloizeaux was elected Membre de l'Institut in 1869, and President of the Académie des Sciences in 1889. The Royal Society awarded him the Rumford Medal in 1870, and elected him a Foreign Member in 1875. He was a founder and the first President (1878) of the Mineralogical Society of France, and again served as its President eleven years later. Other Societies in many parts of the world recognised the value of his scientific work by enrolling him on the list of Honorary Members. An aged widow, a widowed daughter (the Vicomtesse d'Hérouville), and three young grandchildren more especially mourn his loss; but the memory of his kindly character and encouragement will long be treasured up by those who were in any way associated with him.

L. F.

By the death of John Carrick Moore, science loses the last of that band of ardent field-geologists who, during the first half of the present century, did so much to investigate the underground structure of the British Islands. Inspired by the example and animated by the scientific principles of William Smith, they carried out in fuller detail than was possible to their master, his great idea of delineating in maps and sections the distribution and relations of the British strata —guided everywhere by the organic remains which they contain. But while this band of workers—which included such names as those of Buckland, Conybeare, Webster, Mantell, Dixon, Lonsdale, Sedgwick, Murchison, Fitton, De-la-Beche, Godwin-Austen, and Phillips—were so deeply influenced by the teaching of William Smith, yet they were seldom, with the exception of the last-mentioned, personally instructed by him, but derived their knowledge of his principles and methods at second hand from men like Richardson, Townsend, and Farey, who were proud to act as the disciples and interpreters of the distinguished "Father of English Geology."

John Carrick Moore came of a very famous stock. His grandfather, Dr. John Moore, the friend and biographer of Smollett, was the author of many works very famous in his day, of which the novel "Zeluco" has been longest remembered. Three of the sons of Dr. John Moore had very distinguished careers. The eldest surviving son was General Sir John Moore, the hero of Corunna, and a younger son was Admiral Sir Graham Moore, whose exploits on the sea were scarcely less notable than those of his elder brother in the field. The father of John Carrick Moore was James Moore, the second surviving son of Dr. John Moore, who studied medicine in Edinburgh and London, and became one of the most distinguished surgeons of his day. He was the friend of Jenner, and, as a well-known writer in favour of vaccination, was appointed to succeed that surgeon as director of vaccine establishments.

James Moore, who practised extensively for many years in London, was the author of many medical treatises and of a biography of his brother, General Sir John Moore, published in 1833. Having had bequeathed to him by a Mr. Carrick, a banker in Glasgow, the estate of Corsewall, in Wigtownshire, near Stanraer and Port Patrick, James Moore added to his own surname that of Carrick. In 1825 James Carrick Moore retired from practice, and, having built himself an excellent house upon his estate on the shores of Loch Ryan, spent the remainder of his life there, dying in 1834 at the age of 71. On their mother's side, the Moores were descended from Robert Simson, the celebrated geometrician.

John Carrick Moore was the second son of James Carrick Moore, and was born in 1804. He went to Cambridge, and was educated at Queen's College, proceeding to the degree of M.A., and devoting

much attention to mathematics and physics. Before the year 1838, his attention seems to have been attracted by the rocks of the Rhinns of Wigtownshire, near his residence, for we find that he was in communication with Charles Lyell, who identified the fossils found by him as graptolites. In the year named, he was elected a fellow of the Geological Society.

In 1839 he traced out carefully the succession of strata along the west shore of Loch Ryan, and in the following year a paper on the subject was read by him to the Geological Society. In 1841, Sedgwick, crossing from Ireland, paid a visit to Corsewall, and was accompanied by John Carrick Moore in a tour through Ayrshire. In September 1843, Lyell and his wife paid a visit to the same hospitable dwelling, examining and confirming the accuracy of Moore's sections. Much of Lyell's time seems to have been spent in studying the rain- and hail-prints, with the fucoid- and crustacean-markings on the shores of Loch Ryan, and he subsequently wrote to Moore: "The Loch is a grand magazine of geological analogies—tidal, littoral, conchological, sedimentary, &c., which I envy you having at your door." Subsequently to this visit, Lyell, under the direction of Moore, visited the remarkable rocks in the neighbourhood of Ballantrae and bore testimony to the accuracy of his friend's work there.

In 1846 we find John Carrick Moore had become so identified with the work of the Geological Society, that he was elected Secretary, and in the same year he became a member of the Geological Society Club. He held the office of Secretary for six years (1846–52), when he was elected a Vice-President of the Society (1853–4), resuming his post of Secretary in 1855 for one year. So active indeed was Carrick Moore in the administration of the Geological Society's affairs, that between 1846 and 1875 we find him absent from the Council only in four years; he was a Vice-President in 1862, and again in 1864–5. In 1848 he read a more extended paper to the Geological Society on the Silurian rocks of the Wigtownshire coast, the fossils being described and figured by Salter. In 1856 and 1858 Moore communicated accounts of further observations on Wigtownshire geology to the Geological Society, while his general interest in geological research was shown by the papers written by him in 1850 and in 1863, on fossils collected and sent home from San Domingo by Mr. Heniker, and from Jamaica by Lucas Barrett. In 1849 we find him describing the Oligocene fossils found in the New Forest.

John Carrick Moore was proposed as a Fellow of the Royal Society in November, 1855, his nomination paper being signed first by his friend Charles Lyell, while others who subscribed from personal knowledge were Sedgwick, Murchison, Hopkins, Leonard

Horner, and Faraday. He does not appear, however, to have ever contributed a paper to the Society. By his patient labours in studying the geology of Galloway he made valuable additions to our knowledge of the stratified rocks of Britain, and he took a distinguished place among the band of amateur workers—including many landed proprietors, clergymen, soldiers, and doctors—to whose painstaking and detailed work in the field English geology owes so much. Among these men, John Carrick Moore was always held in the highest esteem, and his time and energy were ungrudgingly devoted alike to the advancement of his favourite science by careful studies in the field, and to the promotion of the interests of the Society identified with that science, during the parts of the year when he resided in London.

In 1864, Andrew Ramsay spent a few days with John Carrick Moore at Corsewall, mapping the peninsula, which terminates in Corsewall Point, for the Geological Survey of Scotland. Of John Carrick Moore's wide sympathies with all matters connected with geology, and of the knowledge and ability with which, owing to his early training at Cambridge, he was able to deal with those questions of physical geology demanding an acquaintance with mathematical methods, we have abundant evidence. Between 1865 and 1867, he sent a series of letters to the 'Philosophical Magazine,' dealing in a very able and critical manner with Ramsay's theory of the origin of lake-basins, and with Croll's theory of the cause of the glacial period. These letters show that Moore had not forgotten his early training and had kept himself abreast of the science of the day by his studies of physical questions; and the substantial justice of his criticisms has been abundantly shown by later researches. In 1875 he wrote to 'Nature,' pointing out a curious oversight of Humboldt in his 'Cosmos.'

In 1875, John Carrick Moore finally withdrew from the Council of the Geological Society, upon which he had served so long and so faithfully; and from that time forward he would seem to have ceased to take any active part in scientific work. Few of the present generation of geologists can even recollect having seen the stately and courteous gentleman, who was at one time so indefatigable in the service of their society, and who had so frequently acted as one of its officials. For nearly a quarter of a century after this withdrawal from public activity, however, John Carrick Moore lived on, spending his time between his seat in Wigtownshire and the house in Eaton Square, where he died on February 10, 1898, at the great age of 94. His only son had pre-deceased him, but a daughter survives, the estate passing to his nephew Colonel Sir David Carrick Buchanan, of Drumpellier. Besides the Corsewall estate, John Carrick Moore owned property in Kirkcudbrightshire and in England, and he was

a deputy-lieutenant of the county of Wigtownshire. He was not less highly respected among the gentry of his county and the tenants of his estate than in the circles of scientific society in London, in which his presence was so long conspicuous.

J. W. J.

By the death of Baron FERDINAND VON MUELLER Australia has lost a botanist and geographer who stood in the foremost rank of the scientific men of the southern hemisphere. Ferdinand Jakob Heinrich Mueller was born in 1825 at Rostock, of which town his father was Commissioner of Customs. He was educated for the medical profession at Kiel, where he graduated as Ph.D., after having devoted much of his time as a student to the botany of Schleswig and Holstein. Soon after attaining his majority he was seized with an affection of the lungs, and having lost both parents from consumption, he resolved to seek a more genial climate than that of North Germany. He accordingly in 1847 left for Australia, to which country there was then a considerable emigration from Germany. This was not till after the completion of his first botanical essay, "Breviarium Plantarum Ducatus Slesvicensis austro-occidentalis," which was not published till 1853.* He had meanwhile been enrolled as a member of the German Association for the Advancement of Science, which had just been instituted by Oken.

After his arrival in Australia, Mueller acted for a short time as assistant to a chemist in Adelaide, but being at once fascinated by the interest and novelty of the flora, and having apparently some private means, he gave himself up unreservedly to botanical and geographical exploration. Leaving Adelaide, he crossed over to Victoria in 1848, with the especial object of visiting the then all but unknown Australian Alps, and connecting their flora with that of Tasmania.

During the several years devoted to this object, he, alone and unaided except by the contributions of a few generous friends, displayed great intrepidity as an explorer, penetrating into the interior as far as the Murray River, in crossing which he nearly lost his life, effecting the first triangulation of any part of the Victorian Alps, and making extensive botanical collections abounding in novelty and interest. At the same time he entered into correspondence with botanists in Europe, sending them duplicates of his discoveries, and letters that at once established his reputation as a young naturalist of great attainments and astonishing powers of work.

Amongst his English correspondents was Sir W. Hooker, who interested himself in his favour with Mr. Goulburn, then on the point of leaving England as Lieutenant-Governor of Victoria, and who

* 'Flora,' vol. 36, p. 473.

was desirous of having the vegetable resources of that Colony turned to the best account. This resulted in the creation of a Department of Botany in the public service of Victoria, and the appointment of Mueller to its directorship.

In July, 1855, an expedition was organised at Sydney, with the view of discovering the fate of Leichardt, who in 1847 had started with a fully-equipped party in an endeavour to cross the continent of Australia from east to west, but of whom no tidings had been obtained for seven years. The search party was conducted by Mr. A. C. (afterwards Sir Augustus) Gregory, and Mueller was attached to it as botanist. Leaving Sydney in July of that year in the barque "Monarch," the expedition sailed round the north coast of Australia to the Victoria River, on the north-west coast of the continent, and after spending a year in the exploration of the sources of that river to the 17th degree of S. latitude, it returned by land across the continent, skirting the Gulf of Carpentaria, and finally reaching the Darwin River in Queensland, in November, 1856. During this remarkable journey nearly 20° of unexplored country were traversed, and Mueller, who proved himself an invaluable member of the expedition, obtained magnificent collections of plants abounding in novelties, all carefully annotated and in perfect condition. He subsequently made two other extended land journeys, both in Western Australia, one in 1867, when he explored the country between King George's Sound and the Stirling Range; the other to the district east of Shark's Bay, between the Murchison and Gascoigne Rivers.

In 1857 Mueller was appointed, at a suitable salary, Director of the Melbourne Botanical Gardens, with herbarium, library and laboratory, which post he held till 1873, when he was deprived of the administration of the gardens on the ground of his paying too much attention to the introduction and cultivation of plants of purely scientific interest, and too little to the æsthetic requirements of the Melbourne public, who desired to see their extensive public grounds and garden rival in beauty the far-famed and no less scientific establishment of the same kind at Adelaide in the adjoining colony of South Australia. The fact is, that, great as were Mueller's contributions in many ways to horticulture and gardening in Australia and Europe, he was neither a practical horticulturist nor a landscape gardener. On the occasion of his demission the Colonial Government treated him with great consideration and liberality, retaining his services as Government botanist, with residence, undiminished salary, herbarium, library, and laboratory.

The principal labours of Mueller may be classed under the two heads of scientific and economic botany, especially forestry. It is impos-

sible here to give even a list of his scientific publications. Besides 104 papers registered in this Society's 'Catalogue of Scientific Papers,' he produced many works of exceptional value. Amongst them the most notable are the 'Fragmenta Phytographiæ Australiæ,' begun in 1858 and concluded in 1882, comprised in twelve volumes, a work teeming with critical observations on Australian plants which have been embodied by Bentham in the 'Flora Australiensis'; the 'Eucalyptographia,' a revision of the Gum-trees of Australia, with 129 illustrative plates; the 'Iconography of Australian Salsolaceous Plants,' with 90 plates; the 'Acaciæ and their Allies,' with 130 plates; the 'Myoporineæ,' with 74; and the 'Plants of Victoria,' a fragment, with 90. The descriptive portions of these works leave nothing to be desired from a scientific point of view, and the plates, all in quarto, abounding in anatomical analyses, and executed altogether in the Colony, rival the best of those of European botanical works. In 1882 he published his 'Census of Australian Plants,' in which the ranges of the species in the several Colonies are given, thus initiating a botanical geography of the continent. A second edition appeared in 1889.

From his first years in Australia, Mueller had entertained the ambition of writing a Flora of that continent, and when the several Colonial Governments acceded to the representations of Sir W. Hooker that such a work should be undertaken, and had voted the supplies for its execution, the name of Mueller was naturally the first to be suggested as author. And he no doubt would have been selected but for the fact that without constant access to the Australian collections in the British Museum and at Kew it could not be accomplished. Mueller at once grasped the situation, and, hearing that Bentham had been selected as author, he generously offered the use of the whole of his materials, including that of his immense herbarium, which he transmitted, by instalments, to Kew for the purpose. This great work, commenced in 1863, was concluded in 1878, Mueller loyally aiding by correspondence from beginning to end. Happily his collections were returned to him without the loss of a specimen.

Of Mueller's works in economic botany the most important is the 'Select Extra-tropical Plants, suitable for Industrial Culture or Naturalisation in Australia.' This work is remarkable as a monument of botanical erudition, and, as an economic guide, it is unique of its kind. It passed through many editions in the colony, has been translated into four European languages, and been reprinted in the United States and in India. Besides being the means of introducing many new cultures into Australia, Mueller's activity in sending seeds of Australian plants, especially trees, all over the world, was phenomenal; and to him South Europe, Algeria, India, South and West Africa, California, and South America, are greatly indebted for the groves of

eucalypti, acacias and other trees that have done so much to adorn their hills and plains, and even to improve their climates. To the Royal Gardens, Museums, and Herbarium of Kew he was a perennial contributor of botanical treasures, continuously for upwards of forty years, often at considerable personal cost. Of this the magnificent specimen of the great fern, *Todea barbara*, in the Temperate House, is a conspicuous example. It is a native of gullies in the Victorian Alps, from whence Mueller had it transported by wagon to Melbourne, at his own expense, and shipped from thence, as a gift, to Kew.

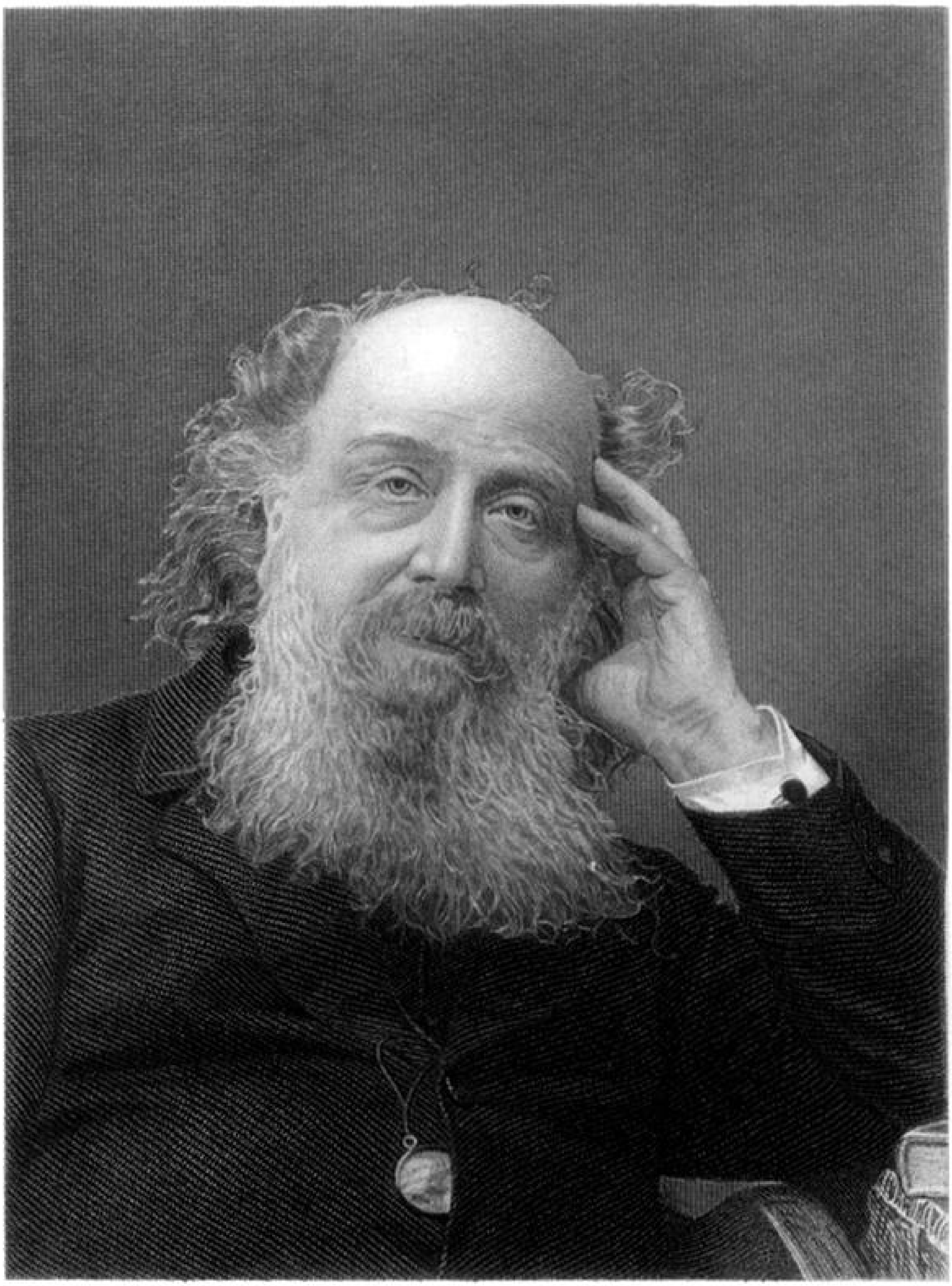
After botany the furtherance of geography was Mueller's constant endeavour. He was President of the Geographical Society of Victoria from its commencement, and author of valuable contributions to its Proceedings. According to a statement in the 'Melbourne Argus,' it was he who induced Sir W. Macgregor to undertake the exploration of New Guinea. He was an active member of Burke and Will's Exploration Committee, and he ceaselessly urged upon the attention of his fellow-colonists the importance of an Antarctic Expedition. No better evidence could be adduced as to the value attached to his own explorations and his efforts in the advancement of geographical knowledge, than that at the Geographical Congress in Vienna he was one of the first to whom a special vote of thanks was awarded for exceptional services in the cause of this science.

Amongst other instances of his devotion to science must be recorded the fact that he was one of the three founders of the now flourishing Royal Society of Victoria, which was established within a year of his arrival in the colony. He was President of the Australian Association for the Advancement of Science at its second session, held in Melbourne in 1889, and was an active member of the Horticultural, Acclimatisation, and various other societies of the Colony. It may further be mentioned, that being a discriminating devotee of music, he was chosen acting President of the Melbourne Liedertafel.

As with many other men of ardent disposition, Baron Mueller had striking personalities. He is described as being of middle height and frugal habits, dressing in black, wearing wooden shoes, and boasting of never having been possessed of a watch or a looking-glass. He was as voluble in conversation as indefatigable in correspondence, asserting that the latter amounted to 3000 letters annually, written with his own hand. His multitudinous titles, and the decorations with which he delighted to adorn himself, were a source of innocent gratification to him, especially his foreign hereditary dignity of Baron, conferred on him by the King of Wurtemburg; and the K.C.M.G. by Her Majesty on the announcement to the Secretary of State for the Colonies of the completion of the

'Flora Australiensis.' He was generous to a fault, devoting the whole of the savings from his official salary to science, charities, and good works. He was elected a fellow of the Linnean Society in 1859, of the Royal in 1861, and was awarded a Royal Medal in 1888. Of other British and foreign scientific societies he held 150 diplomas. He never married. His last and fatal illness was an affection of the brain, of a fortnight's duration, due to study, worry, insomnia, and a total abandonment of bodily exercise. He died in his official residence in Melbourne, October 9th, 1896.

J. D. H.



James Joseph Sylvester.

Engraved by G. J. Stodart, from a Photograph by Messrs. J. Stilliard & Co. Oxford.